Powertrain and Control

MSX00404

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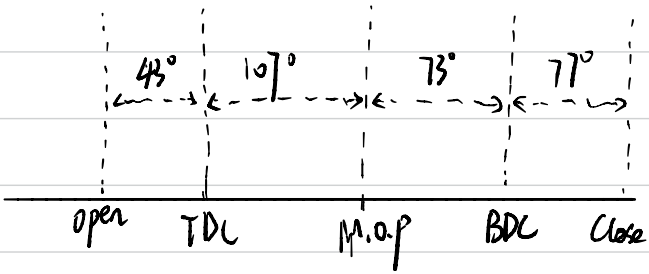
Question Two

a)



duration = 300°

the angle between M.O.P and midpoint between BDC and closing $73° + \frac{77°}{2} = 111.5°$

the intake port length is 60 mm

the time for pulse is $\frac{2n(L+0.06)}{330}$

the time for crank to turn 111.5° at 13800 rpm

$$T = \frac{111.5}{360} \times \frac{60}{13800}$$

So we get

$$\frac{111.5}{360} \times \frac{60}{13800} = \frac{2n(L+0.06)}{330}$$

$$L + 0.06 = \frac{0.444}{2n}$$

$n=1$ $L = 0.162$ m

$n=2$ $L = 0.051$ m

for trumpt length, 0.162 m is more practical

b) similar with (a)

time for crank at 10800 rpm

$$T = \frac{111.5}{360} \times \frac{60}{10800}$$

So we get

$$\frac{111.5}{360} \times \frac{60}{10800} = \frac{2n(L+0.06)}{330}$$

$$L + 0.06 = \frac{0.568}{2n}$$

$n=1$ $\quad L = 0.224$ m

$n=2$ $\quad L = 0.082$ m

0.224 m is more practical

if $n=1$ the length difference is 62 mm, it is acceptable to package these two lengths.

if $n=2$ the length difference is 31 mm, it is less than the situation $n=1$, but the overall length is quite short.

c) repeat the following equation

$$\frac{2n(L+0.06)}{330} = \frac{111.5}{360} \cdot \frac{60}{RPM}$$

we get

	0.162m	0.224 m
1	13812	10797
2	6906	5398
3	4604	3599
4	3453	2699
5	2762	2159

considering the more need on power, 0.162 m provides most useful harmonic spread.

d) ① the pressure pulse in exhaust pipe begins around 20° after the valve opening

② due to the high temprature of exhaust air, the speed of pulse wave is faster, determined by equation $v = v_0\sqrt{\frac{T}{T_0}}$

③ there are more options to assemble the four exhaust pipes.

Question 3.

a) the float occurs when contact force is zero. At this moment, the valve has full lift ($X = 10.66mm$)

according to the moving equation of valve

$$F_c - k(X_0 + x) = ma$$

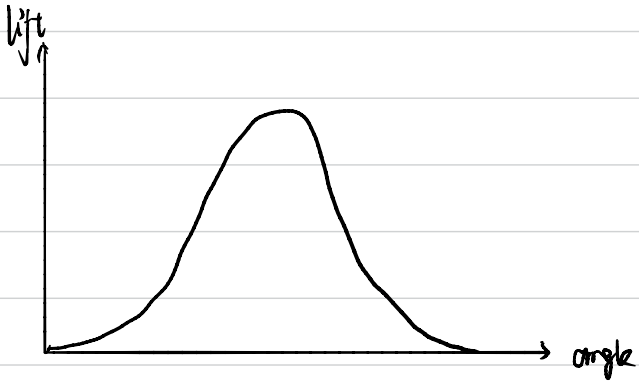
$$0 - 18800(0.004 + 0.01066) = 0.12 \times a$$

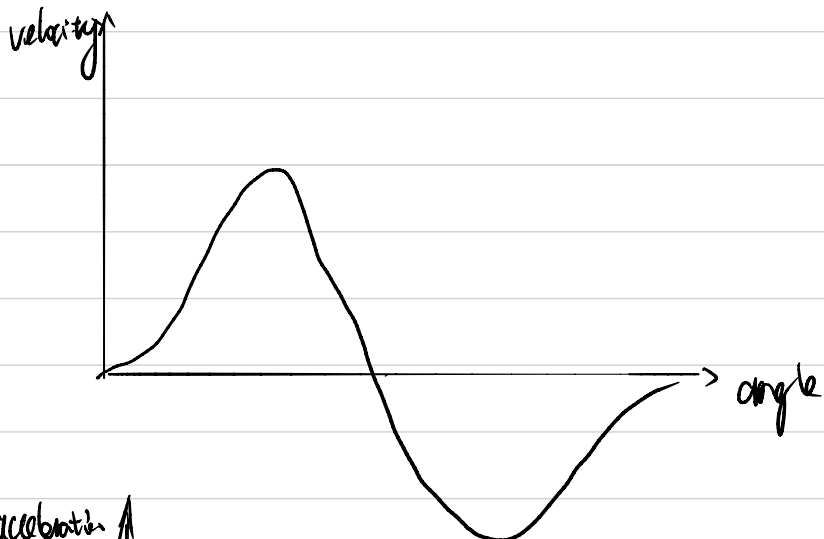
$$a = -1602.4 \ m/s^2$$

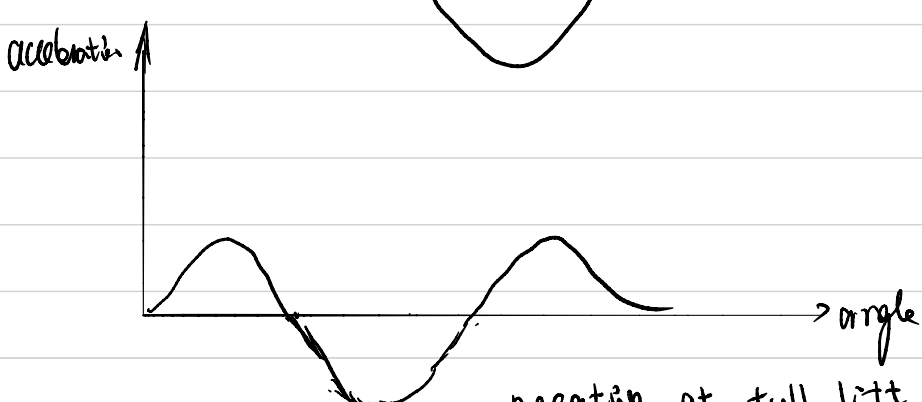
b)

Angle	Lift	velocity	Acceleration
110	10.651		
111	10.654	0.003	
112	10.658	0.004	0.001
113	10.660	0.002	-0.002
114	10.658	-0.002	-0.004
115	10.654	-0.004	-0.002
116	10.651	-0.003	-0.001

c)







negative at full lift

d) max acceleration is -0.004 mm/°

valve acceleration $= \frac{-0.004}{1000} \times (6 \times 3100)^2$

$= 1383.84 \ m/s^2$

This is 86.3 % of acceleration that occuring

e) float occurs at $-1602.4 \ m/s^2$

Then

$$-1602.4 = \frac{-0.004}{1000} \times (6 \times RPM)^2$$

$$(6 \times RPM)^2 = 4.006 \times 10^8$$

$$RPM = \sqrt{\frac{4.006 \times 10^8}{36}}$$

$$RPM = 3336$$

This is cam RPM

the crank RPM is 6672 rpm

safe limit of 6600 rpm will be fine

[I am not sure 875 cc is the displacement volume of one cylinder or two. I calculate as one. If it is total volume, the all calculations concerning volume should be divided by 2]

Question Four.

a) $$\frac{T_2}{T_1} = \left(\frac{V_1}{V_2}\right)^{n-1}$$

$$T_2 = T_1 \cdot \left(\frac{V_1}{V_2}\right)^{n-1} = (32+273) \cdot 10^{1.35-1}$$
$$= 682.8K$$

b) air mass trapped $= 0.9 \times 875 \times 10^{-6} \times 3.52 = 2.772 \times 10^{-3}$ kg

fuel mass trapped $= 2.772 \times 10^{-3} \div 14.7 = 1.886 \times 10^{-4}$ kg

heat output $= 1.886 \times 10^{-4} \times 44 \times 10^{6} \times 0.9 = 7468.56$ J

$$\Delta T = \frac{Q}{mC_v} = \frac{7468.56}{(2.772\times10^{-3} + 1.886\times10^{-4}) \times 100} = 2505.1\ K$$

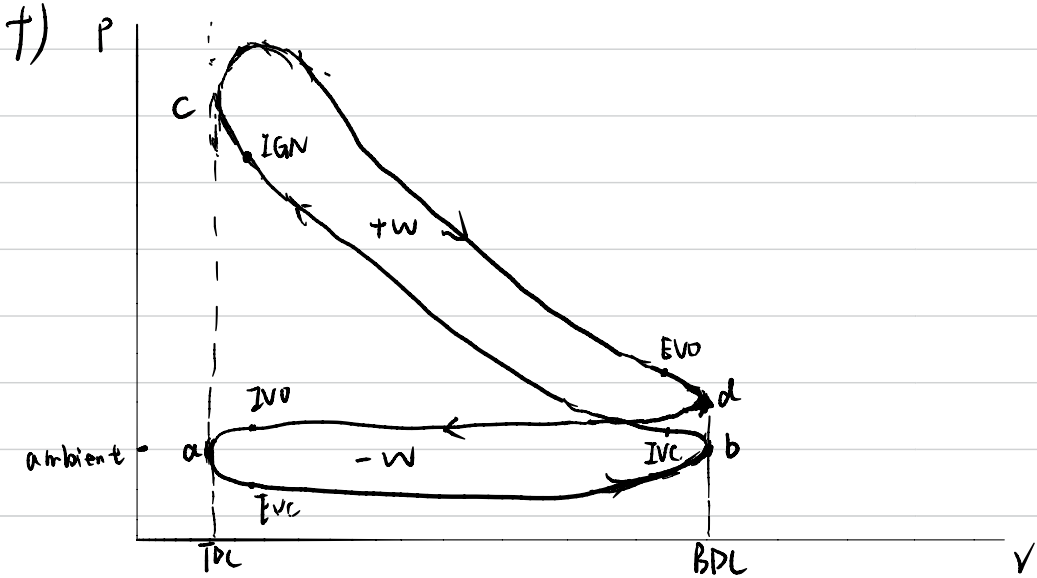
c) $$T_4 = T_3 \left(\frac{V_3}{V_4}\right)^{n-1} = (682.8 + 2505.1) \times 0.1^{0.31}$$
$$= 1561.4K$$

d) $$P_2 = P_1 \cdot \left(\frac{V_1}{V_2}\right)^{n} = 2 \times 10^{1.35} = 44.8 \text{ bar}$$

$$P_3 = P_2 T_3 \cdot T_2^{-1} = \frac{44.8 \times (682.8 + 2505.1)}{682.8} = 209 \text{ bar}$$

e) $$Q = mC_v\Delta T = (2.772\times10^{-3} + 1.886\times10^{-4}) \times 100 \times (1561.4 - 305)$$
$$= 3745.7\ J$$

f)



a-b : inlet

b-c : compression $pv^{n_1} = c$

c-d : expansion $pv^{n_2} = c$

d-a : exhaust